

**LAKE WASHINGTON SECTION 216  
WATER CONSERVATION/BASIN RESTORATION STUDY**

**PRELIMINARY 905(b) ANALYSIS  
Seattle, Washington**

**US Army Corps of Engineers  
Seattle District**

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**LAKE WASHINGTON SHIP CANAL  
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**1. STUDY AUTHORITY.** This study is being conducted under the authority of Section 216, Public Law 91-611, Review of Completed Projects, River, Harbor and Flood Control Act of 1970. The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of completed projects which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to the significantly changed physical or economic conditions. Findings are to be reported to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest.

The Conference Report to PL 101-54, the Energy and Water Development Appropriations Act of the 101<sup>st</sup> Congress, 2<sup>nd</sup> Session, of the House of Representatives, provided \$279,000 for a Section 216 evaluation of the Lake Washington Ship Canal, Washington, for water conservation. A reconnaissance study was initiated in March 1991 under this authority at the request of the City of Seattle. The objective of the study was to determine if there was a federal interest in pursuing further studies to investigate water conservation at the Hiram A. Chittenden Locks. Water conservation measures could be implemented in order to increase withdrawals from the Cedar River, a major tributary to Lake Washington for municipal and industrial water supply. The study was deferred in 1992 because of questions concerning Cedar River instream flow negotiations between Seattle, the local sponsor at the time, and state resource agencies.

In 1994 the City of Seattle requested reactivation of the study (enclosure 1) with support from King County and the State of Washington as a potential new sponsors. In fiscal year 1998, \$100,000 was provided to complete a 905(b) Analysis and Project Study Plan. The local sponsors' interest in the reactivated study is water conservation at the Locks for fish passage and habitat enhancement, as well as other ecosystem restoration opportunities in the entire basin. These goals complement the City of Seattle's ongoing development of a Habitat Conservation Plan for lands in the upper Cedar River basin a major tributary to Lake Washington and King County's efforts to preserve critical habitat throughout the Lake Washington system.

**2. STUDY PURPOSE.** This report is a preliminary analysis, in accordance with the guidelines of Section 905(b) of the Water Resources Act (WRDA) of 1986, to determine if there is a Federal interest in pursuing further studies related to modifications of the existing water resource project, including areas of hydraulic impact. The primary areas of concern to be addressed in the study are water conservation, fish passage facilities at the Locks, and ecosystem restoration in the Lake Washington basin.

**3. LOCATION OF PROJECT.** The project is located in northwest Washington along the west slope of the Cascade Mountain range and includes the cities of Seattle, Bellevue, Redmond, Renton, and Issaquah (reference figure 1). The Lake Washington Ship Canal project encompasses the Hiram A. Chittenden Locks and associated lakes of Lake Washington and Lake Union. The hydraulic effects of the Locks include the Lake Washington basin, Lake Sammamish basin, and the Sammamish River and their tributaries. These systems were significantly altered when the Locks was constructed, changing lake elevations, flooding patterns, and gradients of tributaries. The Lake Washington hydrologic system drains 706 square miles and is comprised of three major sub-basins: the Cedar (188 square miles), the Sammamish sub-basin (240 square miles), and the Lake Washington sub-basin (181 square miles). The Cedar River sub-basin is composed of the Cedar River and its tributaries. The Cedar River flows into the southern end of Lake Washington. The Cedar River was diverted into Lake Washington in approximately 1914, concurrently with the construction of the Ship Canal and Locks and the lowering of Lake

Washington by 9 feet. The Sammamish sub-basin is composed of Lake Sammamish which has a surface area of 4,900 acres and approximately 15 miles of shoreline, tributaries to Lake Sammamish, and the Sammamish River (and its tributaries) which connects Lakes Sammamish and Washington. The Lake Washington sub-basin is composed of Lake Washington and its tributaries (not including the Cedar or Sammamish Rivers), the Ship Canal and Lake Union. The entire basin drains through the Ship Canal, and Lake Union and the Locks into Puget Sound. The Ship Canal and Locks are located within the City of Seattle.

#### **4. PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS.**

- \* The Lake Washington Ship Canal project was completed in 1916. The authorized project purpose is navigation. Fish passage was provided to mitigate for the loss of a stream to the project. The 8-mile-long Lake Washington Ship Canal links Puget Sound with the fresh waters of Salmon Bay, Lake Union, and Lake Washington. The Hiram A. Chittenden Locks provide the navigable connection between salt and fresh waters and controls the elevation of Lake Washington. The locks, spillway, saltwater drain, and fish ladder control outflow of the Lake Washington drainage basin to Puget Sound. The fish ladder and locks enable adult anadromous fish passage from salt to fresh water. A movable saltwater barrier, located in the large lock, reduces saltwater intrusion into Lake Washington during lock operations. The saltwater drain, located near the upstream end of the large lock, returns much of the saltwater to Puget Sound via the original spillway outlet located adjacent to the small lock and through the fish ladder as attraction flows.
- \* Sammamish River Flood Control Project. (1963). At the request of King County, the Corps straightened meanders and dredged the Sammamish River channel in 1963 for flood control. The river length was shortened and the mouths of the major tributaries were modified.
- \* Kenmore Navigation Project. Approved under Section 107 of the 1960 River and Harbor Act, provides for dredging a navigation channel in Lake Washington from deep water to the Kenmore industrial area (northeast end of Lake Washington near the mouth of the Sammamish River). Completed in March 1981.
- \* Sammamish River Section 1135 project, completed in 1995. Three sites along the Sammamish River were enhanced for fish and wildlife habitat benefits with King County as the local sponsor. Improvements included riparian plantings, resloping of the riverbanks, reconnecting a tributary, and placing large woody debris (LWD) to enhance in-water habitat.
- \* Thornton Creek Section 1135, King County. Plans and specifications approved. This project will be constructed in summer of 1998. The project includes the development of wetlands and salmon-rearing area at the mouth of Thornton Creek.
- \* Sammamish Weir Section 1135, King County. Combined planning and design phase approved. This project, to be constructed in the summer of 1998, will improve fish passage through the Sammamish River through modifications to a weir at the outlet from Lake Sammamish and restore riparian habitat.
- \* Bear Creek Section 1135, Redmond. This study is in the feasibility phase. The proposed project would restore meanders and habitat to the lower mile of Bear Creek to improve juvenile salmon winter refuge, rearing habitat, and passage conditions.
- \* Hiram A. Chittenden Locks Section 1135. This current feasibility study is limited to evaluating measures to improve smolt passage at the locks based on existing water conditions. The measures currently under investigation are the addition of smolt slides at the locks to improve juvenile salmon outmigration and provide slower lockages to reduce mortality.
- \* Cedar River Section 205 Flood Control Project, January 1998. This project will provide flood control to the lower one and ¼ mile of the Cedar River in downtown Renton through a combination of levees and channel dredging. This project is currently under construction.

## 5. PLAN FORMULATION.

**a. Identified Problems.** The proposed study would evaluate two significant problems in the Lake Washington Basin: (1) inadequate water quantities to meet economic and environmental resource needs and (2) degraded ecosystem functions and processes necessary to support critical fish and wildlife habitat throughout the basin.

**Water Conservation.** Water needs for navigation, municipal and industrial water supply, fish migration, and water quality (to minimize salt water intrusion) are substantial in the Lake Washington basin and exceed existing availability. The limited quantity of water during the spring and summer months, competing uses for the water, and the increased water demand for environmental concerns and water supply have led to an investigation of potential water conservation measures.

**Habitat Restoration.** Approximately 60-70% of the entire Lake Washington system is developed in urban, suburban, or rural residential development. The Lake Washington sub-basin is nearly 100% developed. Approximately 50% of the Cedar and Sammamish sub-basins are developed. This has significantly increased surface water runoff during precipitation events and reduced groundwater input to streams during dry periods. Future development is expected to further reduce streamflows during dry periods. Pollutants, sediment, and a changed hydrologic regime have detrimentally affected all anadromous salmon in the basin. Puget Sound stocks of chinook salmon (includes Lake Washington runs) have been proposed for listing as a threatened species. Lake Washington runs of wild coho, sockeye, and steelhead have declined dramatically over the last 15 years. The steelhead run has been depleted to less than 100 fish. The State of Washington Department of Fish and Wildlife (WDFW) and numerous other agencies and tribes have undertaken the Lake Washington Ecological Studies Program to determine the specific causes of the decline in the sockeye salmon population. However, the sum of observations and fishery research to date indicates that a comprehensive basin plan to address loss of habitat and possible restoration and fish passage projects is needed.

### (1) **Existing Conditions.**

(a) Ecosystem Restoration. The Lake Washington basin has been significantly modified since 1916. The Corps constructed the Locks and Ship Canal project which lowered the level of Lake Washington by approximately 9 feet and the level of Lake Sammamish by approximately 6 feet. This eliminated shallow-beach spawning areas for salmon and kokanee and severely reduced the number of wetlands in the basin. All tributaries to the lakes were additionally affected by the lowering of the lakes through a change in gradient and alterations in mouth configurations. The natural seasonal fluctuations in Lakes Sammamish and Washington were reduced to a 2-foot range. The Cedar River was diverted from the Green River basin into Lake Washington by a commercial waterway district concurrently with the Locks project. The Cedar River is now the major tributary in the basin (approximately 65% of freshwater input to Lake Washington) with significant runs of sockeye, chinook, and coho salmon and steelhead trout. The Sammamish River system provides close to 35% of the freshwater input to Lake Washington other tributaries to Lake Washington provide minor freshwater flow. The Lake Washington inflow to the Ship Canal from 1980-1995 has been only 80% of the long-term historical average (1939-1995). This has resulted in reduced flows over the spillway at the Locks which is the

optimal passage route for downstream migrating smolt. All anadromous fish must pass through the Ship Canal and Locks as juveniles and then as adults returning to freshwater to spawn. The Lake Washington Ship Canal has had a profound effect on the basin and has facilitated development of floodplains and other areas due to the lowered risk of flooding adjacent to Lakes Washington and Sammamish and the Sammamish River. The tributaries and rivers in the Lake Washington basin are lacking in habitat features that promote salmon survival, such as pools, riffles, large woody debris (LWD), good sources of spawning gravel, and riparian vegetation. These rivers and streams have been straightened and channelized and have extensive areas of continuous glide habitat (moderate velocity and depth areas not suitable for spawning or rearing). The Sammamish River suffers from extremely high temperatures during the late summer months. The Cedar River flows may not be sufficient in late summer to allow adult salmon access for spawning. The shorelines of Lakes Washington and Sammamish and the Ship Canal are nearly entirely developed with bulkheads and other structures that have eliminated nearshore habitat for juvenile salmon migration and rearing. The cumulative effect of all these actions and problems is that salmon habitat has been severely reduced. Wildlife habitat has additionally been reduced by land clearing and development.

(b) Water Conservation. The Ship Canal's authorized and primary project purpose is to provide navigation between Puget Sound and the inland waters of Lakes Union and Washington. As part of the authorizing documents, Lake Washington is to be held between elevation 20' and 22'. The Locks, in combination with the spillway, are used to control the lake level at the downstream end. Inflows into Lake Washington from the Cedar River are influenced by the M&I withdrawals at the City of Seattle's diversion facility at Landsburg located in the upper Cedar River. The State has mandated minimum instream flows for the Cedar river. The 1992 Reconnaissance study investigated the possibility of diverting an additional increment of water from the Cedar River for water supply which would be compensated for through the implementation of water conservation measures at the Locks. Because of environmental concerns, increasing withdrawals (from the Cedar) appears unlikely; however, water conservation measures at the locks could still be investigated to provide potential means to increase flows for fish migration and to decrease saltwater intrusion in the system.

The minimum lake level (20') is held in the winter months to accommodate storage from high-flow events and to minimize wave damage to docks, infrastructure, homes, businesses, and the shoreline. Once the threat of winter storms and flooding passes, the lake is raised to the summer conservation pool of 22'. This additional summer storage in Lake Washington is then used to augment Lake Washington Ship Canal (LWSC) inflows for use in operating the locks and to provide flows for downstream migrating smolts over the spillway, the fish ladder facility, fish attraction flows and the saltwater return system during the summer and fall. By late fall, the lake is again at 20' for the winter storm months. Under existing conditions, the reliability of maintaining the lake level above 20' during the conservation period is 70%. This means that in 3 out of 10 years the lake must be lowered beyond this point to accommodate navigation and other needs at the locks. But the Lake cannot fall below 19.5' without substantial shoreline damages. To meet the authorized project purpose of navigation and to keep the lake above 20' during the conservation period, flows for fish passage may be reduced substantially from an optimal level during dry years. The primary smolt migration period is from April to early July, overlapping the period when efforts to raise the Lake level to the conservation height of 22' are underway. Another constraint and resulting problem from reduced flows is the intrusion of saltwater into Lake Union and the Ship Canal. Saltwater intrusion occurs when the dense Puget Sound

Saltwater enters the LWSC during operation of the two locks. State water quality standards mandate the extent of saltwater concentrations allowed in the system.

To convey the serious problems related to inadequate water at the Locks, preliminary optimal flows for fish passage and saltwater control were identified and computer modeled during the reconnaissance study. Under this condition, flows of 400 cfs would be used over the spillway during May to July for smolt migration followed by flows of 200 cfs for saltwater control during August and September. In an average water year, this would have the effect of lowering the lake level to 16', causing unacceptable and catastrophic impacts to navigation and shoreline infrastructure.

The District has worked diligently over the past 10 years to balance and manage the various water needs and uses in the system. Significant progress has been made in implementing operational water conservation measures to better balance the economic and environmental needs. However, more substantial structural measures are needed to conserve water at the LWSC project to better meet the needs of the system. Local and State agencies and resource groups have also been working to improve fisheries habitat in the basin.

Local government agencies have created two forums The Lake Sammamish Forum, and the Lake Washington/Cedar Forum which are funding a number of salmon life-cycle studies within the Lake Washington system and are developing habitat programs. King County has coordinated the preparation of basin plans for the major tributaries in the Lake Washington system and has funded the acquisition of some critical riparian habitat. The City of Seattle is developing a Habitat Conservation Plan for the upper Cedar basin, and the Washington State Department of Ecology is pursuing water quality issues and cleanup of contaminated sediments in the Lake Union/Ship Canal system. The Muckleshoot Indian Tribe has provided funds for and cooperated in studies at the Locks and throughout the Lake Washington system for salmon restoration.

## **(2) Future Without Project Conditions .**

Within 20 years, it is expected that 75% of the Cedar and Sammamish sub-basins will be heavily developed. This will increase the frequency and quantity of stormwater runoff and further reduce summer low flows in the basin. The City of Seattle will reach mandated minimum flows on the Cedar River with greater frequency (especially during dry summer months). Demands for additional flows for fish migration will continue to increase, especially with the proposed listing of Puget Sound Chinook. Puget Sound stocks of chinook salmon may be listed in March 1999 as a threatened species, and other salmon stocks are likely to be listed in the future (i.e., coho and steelhead). The Corps will need to evaluate a number of changes in Locks operating procedures and structures in response to these listings of threatened and endangered species. King County, the State, local municipalities, and the Muckleshoot Indian Tribe will continue to protect valuable riparian habitat within the Lake Washington basin. Their primary focus will continue to be acquiring remaining undeveloped riparian habitat in fee or through conservation easements, controlling land use and water quality through planning regulation, and public education.

## **(3) Problems and Opportunities**

The following identifies specific objectives and potential solutions to address the water resource problems outlined above.



(a) Ecosystem Restoration. There are several highly visible limiting factors on salmon production: 1) urbanization of the various sub-watersheds has increased flooding, scour, and sediment deposition which, in turn, reduces salmon egg and fry survival; 2) numerous blockages to fish passage exist which eliminate access to good spawning and rearing habitat; 3) lack of riparian vegetation has reduced shading and habitat forming processes (pool formation, etc.); 4) significant populations of non-native fish exist in Lakes Washington and Sammamish with relatively unknown impacts on native fish and zooplankton; and 5) levees and revetments have constrained the floodplains of all tributaries further causing increased flooding, scour, and sediment deposition, as well as eliminating the riparian zone. At the Locks, the existing fish passage facility does not meet current standards for fish ladder design and, furthermore, was not designed with smolt passage in mind. A current 1135 feasibility study will address some of the smolt passage problems at the Locks; but there will likely be additional work that could improve smolt passage, as well as modifying the existing fish ladder for better adult passage.

The ecosystem restoration needs and projects within the basin specifically relate to critical habitat restoration for fish and wildlife. The restoration projects would focus on the following types of needs:

- \* Salmon Spawning,
- \* Salmon and resident fish rearing and refuge areas.
- \* Migration routes for fish and wildlife
- \* Anadromous fish passage through the Locks
- \* Scarce and critical habitat types in the basin for fish and wildlife.

(b) Water Conservation and Fish Passage. The “water budget” of the Lake Washington system is exhausted. There is minimal water available for the increasing demands of M&I water supply, navigation, and fish passage. The Locks is the largest single user of freshwater from the basin. The implementation of water conservation measures at the Locks would provide much needed water to improve fish passage for salmonids, both adults and smolts, at a critical bottleneck to the Lake Washington system, with minimal impacts to navigation and none to existing M&I water supplies.

## **b. Alternative Plans.**

(1) **Restoration Sites**. In coordination with State and Federal fish and wildlife agencies, the Muckleshoot Indian Tribe, King County, Seattle, and other interested parties, the District has determined numerous types of restoration projects and potential project locations that would provide significant benefits to fish and wildlife and address the ecosystem needs outlined above. We identified 21 possible restoration sites during the reconnaissance phase, and assumed up to 18 sites would be recommended for implementation in feasibility. There would be a mix of five types of restoration projects, as described below. Figure 2 indicates the general location of project sites. Reference Table 1 for a breakout of preliminary project costs and benefits. Restoration sites will be screened and selected based upon the following criteria (and other criteria identified during feasibility):

- The expected benefits will accrue to more than one species and extend over a long time period (i.e., 50 years or more)
- The proposed work is compatible with other ongoing efforts by Federal, State, and local agencies.
- Public health, safety, and well-being will be protected.
- Proposed work will not worsen flood control capability of the existing site.

- The project should be designed to minimize the amount of maintenance required for the non-Federal sponsor.
- Proposed work will provide habitat for one of the five critical basin needs listed above.
- Proposed work will enhance habitat for threatened or endangered species that occur in the basin.
- Real estate is reasonably available and is cost effective.
- The non-Federal sponsor is willing and able to operate and maintain the site.
- The proposed project has minimal negative impacts to existing ecosystems.

The sites will be specifically evaluated according to the following methodology to determine the feasibility of implementing a restoration project. All potential river and tributary sites will be initially evaluated following the methodology of the Timber-Fish-Wildlife Ambient Monitoring Program (Northwest Indian Fisheries Commission, 1994 or most recent version) stream survey manual. This will determine the quality of the existing habitat and the potential restoration opportunities at each site. Alternative restoration proposals at each river and tributary site will be assessed using a modified Habitat Evaluation Procedure (HEP) using multiple species appropriate for the site to calculate expected habitat outputs from each alternative proposal. The proposed restoration projects at the lake and Ship Canal will be evaluated based on criteria developed during the feasibility study since very little information is currently known about these areas.

Water conservation projects will be evaluated during feasibility to determine the trade-offs between National Economic Development benefits and environmental benefits (e.g., Delays in navigation versus gains in fish passage from modifications at the locks).

The types of restoration projects that will be investigated during feasibility include:

- **River and Riparian Rehabilitation** --- These types of projects would include levee setbacks, floodplain excavation, reconnection of oxbows, meanders, riparian habitat enhancement. The projects would provide spawning and rearing habitat for salmon in the Lake Washington system and improve transportation corridors. Project locations would include the Cedar River, Sammamish River, and Issaquah Creek. Altogether, these projects cost approximately \$15,901,500 to construct based on reconnaissance-level estimates. Benefits from these projects would include up to 105 acres of riparian and floodplain habitat for fish and wildlife, plus enhanced flood control at some locations.
- **Dam and Blockage Removal/Modification** --- These projects would include removal of small dams on tributary streams, possible removal or modification of larger dams such as the Issaquah Hatchery water intake dam, and investigation of other major blockages. These projects would reopen access to prime salmon habitat. The preliminary construction estimate for these projects is \$1,108,000. Benefits would include more than 20 acres of restored habitat, plus access to 10 miles or more of tributary spawning and rearing habitat which is currently inaccessible.
- **Spawning Site Enhancement** --- These types of projects would include beach spawning areas in Lakes Washington and Sammamish which are very rare and in danger of being eliminated with urban development and possible tributary locations which may be “starved” for gravel. Project costs are estimated at \$1,006,800. Benefits would include the creation or enhancement of up to 9 acres of a very scarce habitat type in Lakes Washington and Sammamish and enhancement of up to 1/2 mile of spawning habitat in the Cedar River or other tributaries.
- **Critical Migratory and Rearing Habitat** --- These types of projects would include nearshore habitat enhancement in critical migratory corridors such as the Ship Canal and would be designed to increase survival of juvenile salmon as they transit through these areas. Approximate construction

costs are estimated at \$981,400. Benefits would include reduced predation on juvenile salmon and increased survival through additional rearing habitat. Holding and thermal refuge areas would be provided for adult salmon. An estimated 5 miles of river and tributary habitat would be enhanced.

- **Fish Passage** --- These projects would include operational/structural changes to the Locks to improve fish passage. Examples could include modifications to the existing fish ladder to enhance adult fish passage, possible smolt passage structures and modifications to the water intake systems to reduce mortality of smolts passing through the Locks, and the use of strobe lights to reduce fish access to common areas of entrapment in the locks. Preliminary construction costs are estimated at \$2,3394,000. Benefits would include enhanced survival for juvenile and adult salmon (up to 5% increase in survival).

Real Estate Data. Table 2 contains reconnaissance-level details of an initial real estate assessment and cost estimate for 21 potential ecosystem restoration sites. The estimated value for most of the sites is fee, except Site 1R located within a state park, and 13 sites within submerged lands that are a part of the navigable waters of the United States. At this time, Seattle District is making the assumption that there is a nexus to commerce and navigational servitude that applies to the sites located within navigable waters of the U.S. Similarly the seven beach spawning sites located on submerged lands and within navigable waters of the U.S. contain docks which may need to be permanently removed to accommodate the spawning sites. Without the benefit of detailed research at this point, the real estate cost contains the assumptions the docks are in place by Section 10 permitting requirements of the River and Harbors Act of 1899, and approval of the Corps of Engineers prior to placement in navigable waters. Because Section 10 permits do not authorize interference with existing or any proposed Federal project, the real estate cost estimate considers the permittee being responsible for paying for any corrective measures to comply with permit conditions. Also, there is the assumption that where there is no acquisition due to the exercise of navigational servitude P.L. 91-646 does not apply. During the feasibility phase of the study a legal investigation of property rights and nexus to commerce to determine application of navigational servitude and P.L. 91-646 will be evaluated for each site.

**(2) Water Conservation.** Several potential measures have been identified which would conserve significant amounts of water during the critical conservation period. Preliminary costs and water savings are summarized below.

- **Water Pumpback System.** This measure would recycle water passing through smolt slides, allowing for increased use of the spillway and/or slides during the outmigration period. Construction costs have been estimated at \$1,819,000. This measure could provide an additional 150 cfs over the spillway for 12 hours a day during the most critical part of the migration period. The measure provides an additional 9,000 acre feet of water for smolt passage.
- **Water Conservation through Salt Water Management.** This alternative would allow a greater intrusion of saltwater into the Ship Canal and Lake Union, reducing the water demand to operate the saltwater drain. Implementation would be influenced by impacts to the Ship Canal ecosystem and would require changes in State water quality standards. Costs and water savings were not developed for this alternative in reconnaissance; most costs will be changes in project operation rather than structural.
- **Bubble Curtain.** This measure includes placing a bubble curtain at the downstream end of the large lock to reduce the amount of saltwater that enters the lock chamber. By reducing the amount of saltwater in the lock, smaller flows would be needed upstream to flush saltwater back to Puget Sound. The estimated cost is \$251,000 which includes a capitalized cost for maintenance. The potential water savings for this measure is 6,000 acre feet.

- **Modification of the Saltwater Drain.** The existing saltwater drain could be modified to more efficiently remove saltwater from the system. The current intake system, located at the pier nose of the large lock, uses a significant amount of fresh water during operation. The modification considered in the 1992 report proposed a modification which would reduce the amount of fresh water used. This option would be evaluated in the feasibility study. The estimated cost is \$4,148,000 and the potential water savings is estimated at 7,400 acre feet.
- **Trade-Off Between NED and NER Water Uses.** Under existing conditions, delays to commercial and recreation vessels can be implemented under drought conditions. This has the effect of conserving water either for fish passage or to maintain the lake at an acceptable level. The potential water savings of implementing delays during average years could be used to augment flows for other uses. The potential water savings and resulting NED impact from this measure, although estimated to be smaller than the structural measures, will be evaluated during the feasibility study.

The following summarizes the potential uses for water that would be realized if structural conservation measures are implemented:

- Provide additional water for smolt and adult fish migration through the project to increase the survival rate for salmon and steelhead.
- Allow enhanced fish passage without significant negative impacts on navigation.
- The potential for future use of conserved water for M&I water supply will be given some consideration in feasibility. However, at this time it appears questionable whether adequate water quantities, with acceptable reliability, are available to make this use economically justified. Further, with the potential for an ESA listing for Puget Sound chinook, it is questionable whether there is a Federal interest in allocating water for M&I use.

#### **b. Alternative Plans.**

Four major alternatives will be evaluated in feasibility:

- 1) No Action;
- 2) Modifications to the Locks for water conservation and fish passage;
- 3) Restoration throughout the basin only without modifications at the Locks, and;
- 4) Water Conservation and fish passage modifications at the Locks plus restoration throughout the basin.

Within each alternative, different levels of modification or restoration will be evaluated. For example, different water conservation and fish passage alternatives will be evaluated, such as a bubble curtain to reduce saltwater intrusion into the ship canal or modifications to the existing fish ladder.

#### **c. Evaluation of Alternatives.**

**1) The No Action alternative** will not meet the needs of providing improved fish passage and water conservation at the Locks nor will it meet basin-wide needs for habitat restoration for fish and wildlife. It is almost certain that the Corps would be required to implement fish passage improvements at the Locks under the requirements of the Endangered Species Act, but in a more piece-meal fashion rather than a comprehensive plan for the basin's needs.

**2) Modifications to the Locks for water conservation and fish passage.** This alternative would increase water availability at the locks and would provide the structural means to apply the water directly to improving both downstream migration of juvenile salmon and upstream migration of salmon and steelhead adults. It would not provide spawning and rearing areas which are in critically short supply throughout the Lake Washington basin but would dramatically improve the only migratory route which all anadromous fish must take to enter the Lake Washington basin. Fish ladder improvements would significantly improve adult salmon access during all tide levels or lake outflow conditions. Additional

juvenile salmon passage improvements would further increase smolt survival by up to 5% of the combined chinook, coho, sockeye, and steelhead populations. Costs for these measures are estimated at \$8,362,000. Potential impacts from this alternative include impacts to navigation (reduced lockages alternative), impacts to the Lake Union/Ship Canal ecosystem (changes in saltwater management), and increased project operation costs. This alternative would significantly enhance fish passage at the Locks but would not address other fish and wildlife habitat needs within the greater basin area..

**3) Basin restoration only.** This alternative would address the overall need in the Lake Washington basin for spawning and rearing sites and migration corridor improvements for salmon but would not remove the major bottleneck to fish migration at the locks. The total cost for this alternative is \$19,193,000. This alternative could provide up to 150 acres of floodplain, riparian, wetland, and new stream channel habitat. Additionally, up to 15 miles of existing river and tributary habitat would be significantly enhanced with the addition of habitat-forming processes and structure (i.e., LWD forms pools, provides cover, etc.). This alternative should not have any significant negative impact to either the environmental nor economic health of the basin. However, negotiating real estate issues for purchase of project lands, particularly in the more developed portions of the basin, will be a major issue in feasibility. This alternative would significantly enhance fish and wildlife habitat throughout the Lake Washington basin but would not address the critical bottleneck at the locks for salmon and steelhead migration.

**4) Water conservation and fish passage at the Locks in combination with basin restoration features.** This alternative meets both the fish passage needs at the Locks and the requirements for critical habitat and improved migration corridors throughout the Lake Washington basin. This alternative has the greatest support of the local sponsors and provides an ecosystem approach to the overall reduction in the numbers of salmon in the Lake Washington basin. Project costs are approximately \$27,555,000. Potential impacts are the same as for alternatives (2) and (3) combined. This alternative would significantly enhance fish passage through the ship canal and Locks, plus provide the additionally created and enhanced habitat throughout the basin for fish and wildlife. This is the recommended plan.

**d. Project Benefits.** The recommended plan contributes significantly to restoring the functions of the ecosystem in an area of prior Federal involvement. The sites initially proposed for restoration have the potential to provide significant improvements to fish and wildlife habitat, provide incidental educational benefits, and maintain or improve flood control conditions. The expected benefits associated with the recommended plan include improvements to critical migratory routes for anadromous fish, significant improvements to rearing and spawning habitat for anadromous fish, restoration and enhancement of stream habitat-forming processes by allowing the reconnection of the rivers and streams with their floodplain and riparian zone, reduction of lethal temperatures in the Sammamish River and possibly other tributaries, creation of floodplain wetland habitat for fish and wildlife, and enhancement of rare and unique habitats such as beach spawning areas in Lakes Washington and Sammamish. The additional habitat which will be opened up or enhanced could produce as many as 38,000 additional chinook, coho, and steelhead juveniles (based on production of coho and steelhead per area of stream). The fish passage improvements at the Locks could increase the overall populations of all anadromous fish by up to 5% (~18,000 adult fish).

A cost effectiveness analysis will be performed during the feasibility stage to determine which sites have the lowest costs for various levels of output. This will be followed by an incremental cost evaluation to identify the combination of projects that represents the best investment. This type of analysis will be used for both the river and lake habitat, as well as wetland and floodplain habitat.

**6. FEDERAL INTEREST.** Alternative 4, Water Conservation and Fish Passage at the Locks in combination with Basin Restoration Features, provides benefits equal to or greater than the cost and, therefore, there is a Federal interest in pursuing this Section 216 study to analyze water conservation and restoration opportunities in the Lake Washington basin. The Corps has had a major historical impact on the Lake Washington ecosystem and hydraulic system which deserves reconsideration. This study would provide high-priority environmental benefits with minimal negative impacts to the environment or the economy. The project is consistent with Army policies and has strong support from local agencies.

**7. PRELIMINARY FINANCIAL ANALYSIS.** Letters of intent from the City of Seattle, King County, and the Washington Department of Ecology are included as enclosure 2. These letters indicate the strong interest of the local governments in working with the Corps to prepare a Project Study Plan and to cost share in a feasibility study and project implementation. Prior to executing the FCSA, the potential sponsors will designate one entity to act as the official non-Federal sponsor.

**8. RECOMMENDATIONS.** Recommend approval for completion of the Project Study Plan for the Lake Washington Section 216 feasibility study. This study has a clear Federal interest, strong local support, and conforms to current Army policy. This study would tie closely with the needs of local governments and the Corps to develop plans to protect Puget Sound chinook salmon and other declining salmon species in the Lake Washington basin.

**9. POTENTIAL ISSUES AFFECTING INITIATION OF FEASIBILITY PHASE.** Local agencies in the greater Seattle area and the Corps share a strong interest in arresting the continual decline of salmon in the Lake Washington basin. This has been focused by the consideration of an ESA listing for Puget Sound chinook. This study would provide the format for a regional, shared approach to restoring the Lake Washington basin for fish and wildlife and has the strong support of regional governments.

**10. PROJECT AREA MAP.** Reference figures 1 and 2.

Date \_\_\_\_\_

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James M. Rigsby  
Colonel, Corps of Engineers  
Seattle District

